

Overview of the Tectonic Setting and Geology of Porphyry Copper-Gold Deposits Along the Eastern Sunda Magmatic Arc, Indonesia

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With the recent discovery of the world-class Tumpangpitu gold-silver-copper deposit at Tujuh Bukit (1.9 Gt at 0.45% Cu, 0.45 g/t Au), the eastern Sunda arc has proven itself as a major porphyry metallogenic belt. It contains three world-class porphyry Cu-Au deposits at Batu Hijau, Elang, and Tumpangpitu (10+ Moz Au, 5+ Mt Cu), together with significant high sulfidation epithermal deposits (0.5+ Moz Au). Mineralization is confined to the eastern segment (East Java to Sumbawa), where the Roo Rise is being subducted beneath the island arc. In contrast, the subeconomic porphyry prospects at Selogiri, Ciemas, and Cihurip with dominant low sulfidation epithermal deposits at Pongkor, Cikotok, Cibaliung, Cikondang, and Arinem occur along the western segment of the arc (West to Central Java), developed on thick continental crust on the southern margin of Sundaland associated with “normal” thin Indian oceanic crust subduction.

The main porphyry Cu-Au deposits are spatially associated with small Neogene, nested, dioritic to tonalitic intrusive complexes with low-K calc-alkaline to weakly alkaline, dioritic to tonalitic compositions. Intrusion ages range from 2.7 Ma at Elang to 3.7 Ma at Batu Hijau to 7.5 Ma at Selodong. Mineralizing intrusive bodies consist of multiple phases: early, intermediate, and late tonalite intrusions, with latest intrusive activity marked by postmineralization diatreme breccia bodies which are developed at the margin or adjacent to the porphyry systems and disrupt the mineralized bodies. The intrusions are elongate, with pencil-like geometries 200 to 500 m in diameter and with 2+-km vertical extent. The porphyries are hosted by or intruded the margins of coarse-grained, equigranular stocks and batholiths. The depth of emplacement for the porphyry intrusions ranges from 1 to 2 to 5 km below the paleosurface.

Hypogene copper-gold mineralization at the three giant porphyry deposits, as marked by the 0.3% Cu zones in surface projections of drill hole data, measures on average more than 1 km in diameter and has about 1 km of vertical extent. Bornite and chalcopyrite are the dominant copper sulfide minerals and define bornite-rich cores, chalcopyrite-rich halos, and peripheral pyrite shells at each deposit. Hypogene alteration assemblages, veins, and sulfide mineralization developed in three main temporally and spatially overlapping events, termed early, transitional, and late. Gold and copper mineralization is directly related to quartz veining and defines an annular or inverted shell that lies within and around the margins of the tonalites. Early veins contain the bulk of the hypogene gold, chalcocite, digenite, and bornite. Transitional-stage veins contain chalcopyrite with minor or trace bornite. Supergene copper mineralization is only developed beneath goethitic leached caps at Batu Hijau and Elang, where a weak chalcocite blanket averaging 40 m thick and 0.5 to 0.7% Cu (500 × 750 m in plan view) underlies a goethite-hematite leached cap at the surface.

The porphyry deposits are typically associated with large lithocaps (20+ km²). The lithocaps at Hu'u, Brambang, and Tumpangpitu are well preserved, but they are deeply eroded at Batu Hijau and Elang. High sulfidation epithermal gold-silver veins are developed within lithocaps at Elang, Selodong, Brambang, and Tumpangpitu.